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(56) Documents Cited
US 5411105 A **US 5249635 A**

(58) Field of Search
UK CL (Edition P) **E1F FGL**
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Online: WPI

(54) Abstract Title
Balanced or underbalanced drilling

(57) A method and apparatus which enables cased wellbores to be drilled deeper without causing unnecessary damage to the formation, wherein a first string (14) containing valves is run into the cased wellbore (W) to define an outer annulus (21) with the wellbore casing (W). The outer annulus (21) is sealed by a packer (18), and a bit (12) on a drillstring (10) is run through the first string (14) to define an inner annulus (46) between the drillstring (10) and the first string (14). The outer annulus (21), or parasite annulus, is able to communicate with circulating mud in the inner annulus (46) by means of the valves in the first string (14). The valves are set at various depths, and are hydraulic pressure balanced so that only an increase in the pressure of a gas in the outer annulus (21) acts to open them. Each valve is adjustable to alter the amount of differential pressure required in order to open it, and are closed by a spring bias. The injection of gas, through these valves, into the circulating mud reduces the density of the mud and hence reduces the pressure which is exerted upon the formation by the mud in the inner annulus (46).

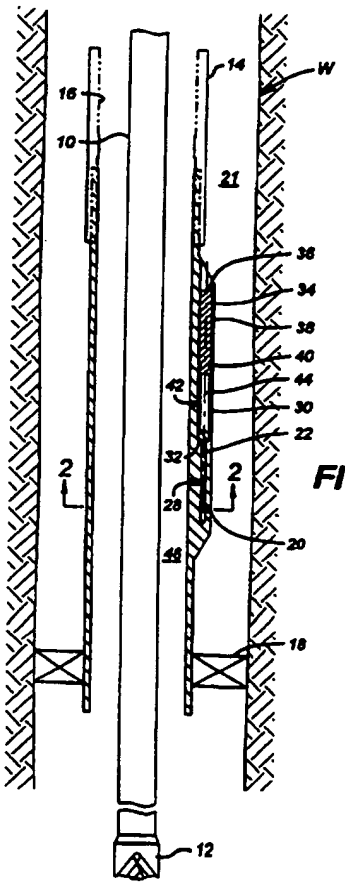

FIG. 1

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy

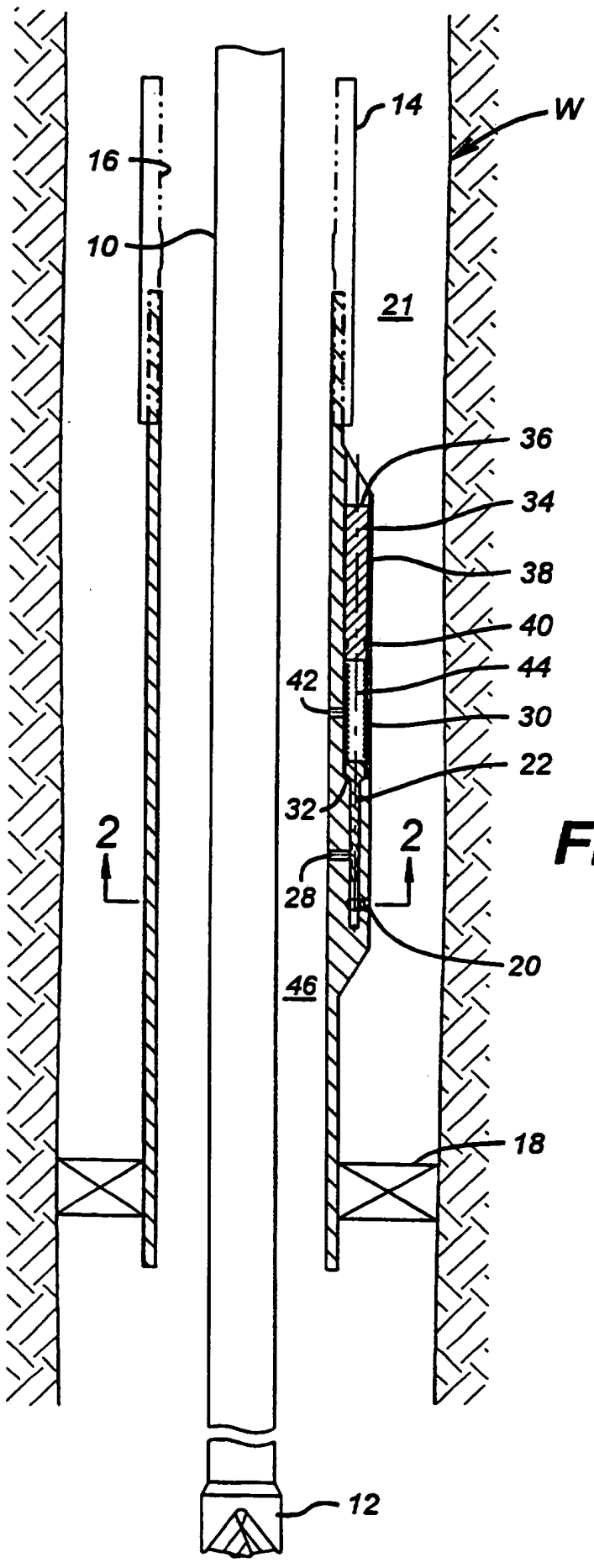

FIG. 1

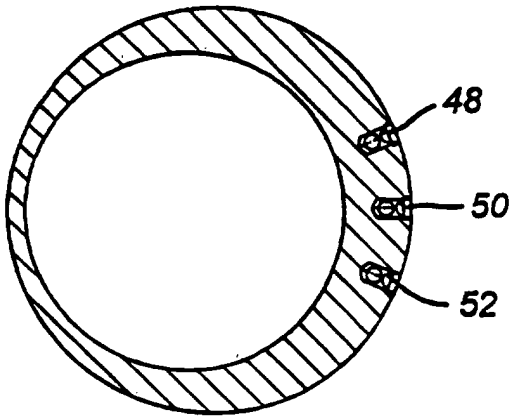

FIG. 2

TITLE: BALANCED OR UNDERBALANCED DRILLING METHOD AND APPARATUS

INVENTOR: GARY E. COOPER, ALEX CRABTREE, and DAVID CAMERON

FIELD OF THE INVENTION

The field of this invention relates to drilling, particularly drilling in a balanced or underbalanced condition.

BACKGROUND OF THE INVENTION

Drilling mud is circulated in the borehole through the drill bit to facilitate the drilling process. The circulating mud takes away the cuttings formed by the drill bit and brings them to the surface, where they are separated from the drilling fluid and the drilling fluid is recycled. As the well is drilled deeper, the column of mud acting on the formation at the bottom of the wellbore grows longer, thereby exerting a greater pressure on the formation. In certain formations, the presence of pressure on the pay zone, even during drilling, can adversely affect the ultimate performance of the well when it is brought in, due to formation damage caused by the drilling medium invading virgin formation.

In the past, the techniques that have been employed to address this problem have involved an insertion of a tubular with gas injection behind the tubular in an annular space at the periphery of the wellbore. The gas is inserted at the surface and must pass to the bottom of the tubular in order to come up and around inside the tubular back to the surface. Thus, attempts to lighten the pressure exerted on the formation by the column of mud in the wellbore being drilled have been limited due to the inability to inject gas at any other point except close to the bottom of the wellbore. The density of the

circulating mud changes during the drilling operation and, thus, the ability to only inject gas very near the drill bit at times does not permit proper control to maintain the balanced or underbalanced condition. Underbalanced drilling has been attempted using nitrified drilling fluid or other light drilling fluids. However, these techniques had problems.

Various designs of tubing valves used downhole are illustrated in U.S. patents 3,583,481; 4,602,684; 4,257,484; 3,407,830; and 3,398,760.

Accordingly, one of the objectives of the present invention is to provide access from a parasite annulus along the length of the annulus so that injection can occur at various depths. Another objective is to provide adjustability for each of the communication valves through from the parasite annulus to allow more control of the distribution of gas from the parasite annulus into the mud column for better controlled drilling conditions.

SUMMARY OF THE INVENTION

A casing or tubing segment or segments are disclosed which can be used to create a parasite annulus during drilling. The cased wellbore receives a string containing valves and the drillstring operates through it. As the mud circulates, the segments of the tubing or casing provide communication at various depths from the parasite annulus (*i.e.*, the outermost annulus) into the circulating mud, which is the innermost annulus. Each valve is adjustable to alter the amount of differential pressure required in order to open it. The valves are also in hydraulic pressure balance so that only the pressure added by the injected gas acts to open them. The valves close by a spring bias.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a sectional elevational view showing one of many segments of a casing or tubing string which forms the parasite annulus and the valve mechanism therein.

Figure 2 is the view along lines 2–2 of Figure 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Figure 1 illustrates in section a cased wellbore **W** which is being further drilled. The drillstring **10** is connected to a bit **12**, shown schematically. Inserted in the wellbore **W** is the parasite casing or tubing string **14**, a portion of which is shown in the wellbore **W** of Figure 1. The valve assembly, as illustrated, can appear in different segments as a portion of the parasite string **14**. This is illustrated by providing a thread **16** to allow identical sections of the string **14** to be installed at various depths in the wellbore **W**. Toward the lower-most end, which is illustrated in Figure 1, a packer **18** seals off the parasite or outer annulus **21**. Gas injection occurs from the surface into the parasite annulus **21**. The gas is prevented from passing by packer **18** and, therefore, acts on opening **20**, which provides access to needle **22**. Needle **22** has seals points **24** and **26** which in the position shown in Figure 1 straddle outlet **28**. Spring **30** biases needle **22** to the position shown in Figure 1 where shoulder **32** acts as a travel stop for needle **22**. The amount of preload on spring **30** is adjusted by turning adjusting screw **34**, which has a hex head **36** and is retained by threads **38** to the string **14**. Seal **40** seals the threaded connection at **38**. An equalizing port **42** communicates with cavity **44** to allow the pressure in inner annulus **46** to enter the cavity **44**. With opening **20** providing access to parasite annulus **21** and the pressure in inner annulus **46**

communicating with cavity **44** through opening **42**, the needle **22** is close to hydraulic balance with spring **30** keeping the needle **22** seated against its travel stop **32**. When, during drilling, a balanced or underbalanced condition is desired, gas is injected from the surface into the parasite annulus **21**. The adjusting screws **34** can be preadjusted at the surface so as to provide a greater preload for the assemblies nearer the surface than those further down to discourage short circuiting of the gas in the parasite annulus **21** into the upper portions of the annulus **46**. Alternatively, the adjusting screws **34** can be set to favor initial flow from annulus **21** into annulus **46** closer to the surface with additional flow further downhole as a result of additional pressure applied to annulus **21**.

Figure 2 indicates that each segment of the string **14** has the valve assemblies, as described, in an eccentric manner. Each valve assembly **48**, **50**, and **52** are offset from each other, preferably about 22°, and are eccentric to the center line of the parasite string **14**. Among a given group of valve assemblies **48**, **50**, and **52**, the setting for preload can be different so that as pressure is increased in annulus **21**, additional valves at the same elevation will open.

Those skilled in the art can appreciate that the string **14** can be lengthened as the drilling progresses by a sequential release of the packer **18** and addition of further components from the surface so that the string **14** comes close to the position of the bit **12**. As the drilling progresses, the string **14** is lengthened after a predetermined amount of drilling has occurred. The string **14** does not have to reach as far down as the bit. The degree of underbalance, as well as well conditions, will determine the length of string **14** during drilling.

Using known techniques to compute the amount of decrease in density of the mud column, the layout, as illustrated above, can be used to facilitate injection of gas throughout the string to facilitate the drilling operation. The same valve assembly, such as **48**, **50**, and **52**, disposed at different heights could also subsequently be used in a production string as a gas-lift technique to stimulate the well to flow to the surface in low-pressure formations. The advantage of the present invention can be readily seen during drilling where injection at preselected points can be determined, allowing better feedback at the surface of the effects of the gas injection through the various portions of the string **14**. With better control during the drilling operation, less damage is done to the formation during drilling, which enhances the possibilities of better production when the well is put in service. Through the use of the parasite string **14**, better control of mud density is accomplished, which reduces the possibility of formation damage and is more dependable than prior techniques of control of mud density, because the feedback obtained with gas injection as to pressure exerted on the formation is much faster than known alternatives.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made without departing from the spirit of the invention.

CLAIMS

1. A method of drilling a cased wellbore deeper, comprising:

running in a first string to define an outer annulus with the cased wellbore;

sealing said outer annulus between said first string and the cased wellbore;

running in a bit on a drillstring through said first string to define an inner annulus between said drillstring and said first string;

injecting gas into said inner annulus from said outer annulus into drilling fluids flowing up said inner annulus to the surface.

2. The method of claim 1, further comprising:

using at least one injection valve mounted to said first string to selectively allow gas to pass from said outer annulus to said inner annulus.

3. The method of claim 2, further comprising:

using a plurality of valves at different depths along said first string.

4. The method of claim 2, further comprising:

providing a plurality of valves at a given depth on said first string.

5. The method of claim 3, wherein:

said valves are configured to open at different depths as the pressure in said outer annulus is increased.

6. The method of claim 3, wherein:

said valves are configured to open at different depths at substantially a predetermined pressure in said outer annulus.

7. The method of claim 2, further comprising:

pressure-balancing said valve as between said outer and inner annulus.

8. The method of claim 7, further comprising:

applying a biasing force to hold said valve closed until a predetermined differential pressure across said valve is reached.

9. The method of claim 8, further comprising:

adjusting the amount of preload biasing force on said valve so that it doesn't open until a predetermined force is applied.

10. The method of claim 9, further comprising:

using a plurality of valves at different depths along said first string.

11. The method of claim 9, further comprising:

providing a plurality of valves at a given depth on said first string.

12. The method of claim 10, wherein:

said valves are configured to open at different depths as the pressure in said outer annulus is increased.

13. The method of claim 13, wherein:

said valves are configured to open at different depths at substantially a predetermined pressure in said outer annulus.

14. The method of claim 1, further comprising:

increasing the length of said first string as the drilling progresses.

15. The method of claim 1, further comprising:

creating an underbalanced condition at the drill bit due to said injecting.

16. The method of claim 1, further comprising:

creating a balanced condition at the drill bit due to said injecting.

Amendments to the claims have been filed as follows

1. A method of drilling a cased wellbore deeper, comprising:

running in a first string to define an outer annulus with the cased wellbore;

sealing said outer annulus between said first string and the cased wellbore;

running in a bit on a drillstring through said first string to define an inner annulus between said drillstring and said first string;

circulating drilling fluids through the bit and out of the wellbore through said inner annulus;

injecting gas into said inner annulus from said outer annulus into drilling fluids flowing up said inner annulus to the surface; and

reducing the density of the circulating drilling fluids by said injection of gas.

2. The method of claim 1, further comprising:

using at least one injection valve mounted to said first string to selectively allow gas to pass from said outer annulus to said inner annulus.

3. The method of claim 2, further comprising:

using a plurality of valves at different depths along said first string.

4. The method of claim 2, further comprising:

providing a plurality of valves at a given depth on said first string.

5. The method of claim 3, wherein:

said valves are configured to open at different depths as the pressure in said outer annulus is increased.

6. The method of claim 3, wherein:

said valves are configured to open at different depths at substantially a predetermined pressure in said outer annulus.

7. The method of claim 2, further comprising:

pressure-balancing said valve as between said outer and inner annulus by exposing opposed surfaces on said valve to said outer and inner annulus.

8. The method of claim 7, further comprising:

applying a biasing force to hold said valve closed until a predetermined differential pressure across said valve is reached.

9. The method of claim 8, further comprising:

adjusting the amount of preload biasing force on said valve so that it doesn't open until a predetermined force is applied.

10. The method of claim 9, further comprising:

using a plurality of valves at different depths along said

first string.

11. The method of claim 9, further comprising:

providing a plurality of valves at a given depth on said first string.

12. The method of claim 10, wherein:

said valves are configured to open at different depths as the pressure in said outer annulus is increased.

13. The method of claim 13, wherein:

said valves are configured to open at different depths at substantially a predetermined pressure in said outer annulus.

14. The method of claim 1, further comprising:

increasing the length of said first string as the drilling progresses.

15. The method of claim 1, further comprising:

creating an underbalanced condition at the drill bit due to said injecting.

16. The method of claim 1, further comprising:

creating a balanced condition at the drill bit due to said injecting.

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Patent Office

Application No:	GB 9803841.7	**Examiner:**	Caroline Marshall
Claims searched:	1-16	**Date of search:**	29 July 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): E1F (FGL)

Int Cl (Ed.6): E21B 21/00, 21/14.

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	US 5 411 105	(Kidco Resources Ltd.) - see whole document.	-
A	US 5 249 635	(Marathon Oil Company) - see whole document.	-

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.